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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Hirofumi KAWASHIMA	Group Art Unit: NOT YET ASSIGNED
Serial No.: NOT YET ASSIGNED (Filed herewith)	Examiner: NOT YET ASSIGNED
Filed: October 11, 2001	
For: QUARTZ CRYSTAL TUNING FORK RESONATOR	

Assistant Commissioner for Patents
Washington, D.C. 20231

S I R:

PRELIMINARY AMENDMENT

Applicants request entry of the following Preliminary Amendment into the file of the subject application prior to determination of the filing fee for the application and commencement of examination of the application on the merits.

IN THE CLAIMS

Amend the claims as follows:

Amend original claims 1 – 17, as follows:

1. (Amended) A quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, the resonator comprising:

a plurality of quartz crystal tuning fork tines, each tuning fork tine having sides and a central linear portion;

a quartz crystal tuning fork base, to which the plurality of quartz crystal tuning fork tines are attached;

at least one groove provided in the central linear portion of each of the plurality of tuning fork tines;

at least one first electrode provided inside each groove; and

at least one second electrode provided on the sides of the tuning fork tines;

such that for each tuning fork tine each one of the at least one second electrode has an opposite electrical polarity to the electrical polarity of each one of the at least one first electrode.

2. (Amended) The resonator according to claim 1, wherein:

the at least one first electrode inside the at least one groove of a first tuning fork tine and the at least one second electrode disposed on the sides of a second tuning fork tine have the same first electrical polarity, and

the at least one second electrode disposed on the sides of the first tuning fork tine and the at least one first electrode inside the at least one groove of the second tuning fork tine have a second, opposite electrical polarity to the first electrical polarity.

3. (Amended) The resonator according to claim 2, wherein the second electrode on outer facing sides of each of the first and second tuning fork tines that are each adjacent to only one other side of the same or another tuning fork tine on the tuning fork base, constitute two electrode terminals.

4. (Amended) The resonator according to claim 1, wherein the at least one groove provided on the central linear portion of each of the first and second tuning fork tines extends to the tuning fork base to which each tuning fork tine is attached.

5. (Amended) The resonator according to claim 1, wherein a width W_2 of each groove on the first and second tuning fork tines is greater than or equal to a width W_1, W_3, measured from an outer edge of the groove to an outer edge of the tuning fork tine.

6. (Amended) A quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, the resonator comprising:

a plurality of quartz crystal tuning fork tines;

a quartz crystal tuning fork base, having an obverse face and a reverse face, and to which the plurality of quartz crystal tuning fork tines are attached;

a plurality of grooves provided on the quartz crystal tuning fork base where the plurality of quartz crystal tuning fork tines are attached to the quartz crystal tuning fork base; and

a plurality of electrodes provided in the grooves, such that there is at least one electrode in each groove.

7. (Amended) The resonator according to claim 6, wherein:

a first set of grooves is provided on the obverse and the reverse faces of the tuning fork base, where each tuning fork tine is attached to the base; and

a second set of grooves is provided on the obverse and the reverse faces of the tuning fork base, such that there is a second groove between each adjacent pair of first grooves.

8. (Amended) The resonator according to claim 6, wherein:

the electrodes disposed opposite each other in the thickness direction of the grooves have the same polarity, and

the electrodes disposed opposite the sides of adjoining grooves have opposite polarities.

9. (Amended) ~~A~~ The quartz crystal tuning fork resonator ~~as defined in any proceeding claim~~ according to claim 6, wherein the tuning fork base has a plurality of grooves, and ~~said grooves containing the electrodes~~ each groove contains an electrode.

10. (Amended) A quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising;

a plurality of quartz crystal tuning fork tines;

a quartz crystal tuning fork base, to which the plurality of quartz crystal tuning fork tines are attached;

each of the quartz crystal tuning fork tines having step difference portions;

with there being at least one first electrode on each of the step difference portions;

with there being at least one second electrode disposed on sides of the quartz crystal tuning fork tines, and;

such that the at least one first electrode and the at least one second electrode are of opposite electrical polarity.

11. (Amended) An integrated quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising a plurality of individual resonators according to claim 1.

12. (Amended) The integrated quartz crystal tuning fork resonator according to claim 11, wherein each of the plurality of individual resonators is connected to at least one other individual resonator of the plurality of resonators at their corresponding respective quartz crystal tuning fork bases.

13. (Amended) The integrated quartz crystal tuning fork resonator according to claim 11, wherein the corresponding respective tuning fork bases of individual resonators that are connected to one another form an angle of from 0° to about 30°.

14. (Amended) The integrated quartz crystal tuning fork resonator according to claim 11, wherein each of the plurality of individual quartz crystal tuning fork resonators has at least one of a different shape and a different electrode configuration.

15. (Amended) The resonator according to claim 11, wherein the individual resonators are electrically connected in series.

16. (Amended) The resonator according to claim 11, wherein the individual resonators are electrically connected in parallel.

17. (Amended) The resonator according to claim 1, wherein the grooves formed on the tuning fork tines are holes or a combination of grooves and holes, and the holes or grooves and holes contain the at least one first electrodes.

Add new claims 18 - 38, as follows:

18. (New) The quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, according to claim 1, wherein there are two tuning fork tines.

19. (New) The quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, according to claim 6, wherein there are two tuning fork tines.

20. (New) The quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, according to claim 10, wherein there are two tuning fork tines.

21. (New) The quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, according to claim 1, wherein each quartz crystal tuning fork tine has one groove; each groove has one first electrode thereinside; and each tuning fork tine has two sides with one second electrode on each side.

22. (New) An integrated quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising a plurality of individual resonators according to claim 6.

23. (New) An integrated quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising a plurality of individual resonators according to claim 10.

24. (New) The integrated quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, according to claim 11, wherein there are two individual resonators.

25. (New) The integrated quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, according to claim 22, wherein there are two individual resonators.

26. (New) The integrated quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, according to claim 23, wherein there are two individual resonators.

27. (New) An integrated quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising a plurality of individual quartz crystal tuning fork resonators, each capable of vibrating in a flexural mode, the plurality of individual resonators being selected from the group consisting of:

A.) a quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising:

a plurality of quartz crystal tuning fork tines, each tuning fork tine having sides and a central linear portion;

a quartz crystal tuning fork base, to which the plurality of quartz crystal tuning fork tines are attached;

at least one groove provided in the central linear portion of each of the plurality of tuning fork tines;

at least one first electrode provided inside each groove; and

at least one second electrode provided on the sides of the tuning fork tines;

such that for each tuning fork tine each one of the at least one second electrode has an opposite electrical polarity to the electrical polarity of each one of the at least one first electrode;

B.) a quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising:

a plurality of quartz crystal tuning fork tines;

a quartz crystal tuning fork base, having an obverse face and a reverse face, and to which the plurality of quartz crystal tuning fork tines are attached;

a plurality of grooves provided on the quartz crystal tuning fork base where the plurality of quartz crystal tuning fork tines are attached to the quartz crystal tuning fork base; and

a plurality of electrodes provided in the grooves, such that there is at least one electrode in each groove;

C.) a quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising;

a plurality of quartz crystal tuning fork tines;

a quartz crystal tuning fork base, to which the plurality of quartz crystal tuning fork tines are attached;

each of the quartz crystal tuning fork tines having step difference portions;

with there being at least one first electrode on each of the step difference portions;

with there being at least one second electrode disposed on sides of the quartz crystal tuning fork tines, and;

such that the at least one first electrode and the at least one second electrode are of opposite electrical polarity; and

D.) a combination of individual resonators according to at least two of A, B, and C.

28. (New) A quartz crystal tuning fork resonator capable of vibrating in a flexural mode, the resonator comprising:

a.) a quartz crystal tuning fork base;

b.) first and second quartz crystal tuning fork tines, each tuning fork tine being parallelipiped in shape and having:

a base end that is attached to the tuning fork base, and a free top end opposite to the base end, the base end and the top end having a width and a length;

a pair of central surfaces, including a central upper surface and a central lower surface, the central upper surface and the central lower surface being disposed opposite to one another, and both of the central upper and lower surfaces being perpendicular to the base and top ends, with the central upper and lower surfaces having a width and a height; and

a pair of opposite first and second side surfaces, both of which are perpendicular to the base and top ends and perpendicular to the central upper and lower central surfaces, with each of the first and second side surfaces having a length and a height;

with each of the first and second tuning fork tines being adjacent to at least one other tuning fork tine, and spaced apart therefrom on the tuning fork base by a predetermined distance, such that at least one of the first and second side surfaces of each tuning fork tine is adjacent to a side surface of at least one other adjacent tuning fork tine and is spaced apart therefrom by the predetermined distance between adjacent tuning fork tines;

c.) a plurality of grooves, with a groove being provided in at least one of the central upper and central lower surfaces of each of the tuning fork tines, such that there is at least one groove on each tuning fork tine, and with each groove having an overall rectangular shape, with a width that is less than the width of the base and free top ends of the tuning fork tine, and a height that is less than the height of a central upper or lower surface or first or second side surface of the tuning fork tine, and having a depth extending into the tuning fork tine;

d.) a plurality of first electrodes, with a first electrode being provided inside each of the grooves on each tuning fork tine, such that there is at least one first electrode in each groove on each tuning fork tine, with each first electrode having a predetermined electrical polarity, and further such that where there is more than one first electrode in each groove on each tuning fork tine; each first electrode on the same tuning fork tine has the same electrical polarity;

e.) a plurality of second electrodes provided on the side surfaces of the tuning fork tines, with each second electrode having a predetermined electrical polarity, such that there is at least one second electrode on each of the first and second side surfaces of each tuning fork tine, and further such that the electrical polarity of each second electrode on a given tuning fork tine is opposite to the electrical polarity of the at least one first electrode on that tuning fork tine; and further such that all first electrodes on a given tuning fork tine are electrically connected to all second electrodes of like polarity on all immediately adjacent tuning fork tines, and all second electrodes on the given tuning fork tine are electrically connected to all first electrodes of like polarity on all immediately adjacent tuning fork tines, with a pair of electrode terminals of opposite electrical polarity being formed at respective exterior-facing side electrodes of respective end tuning fork tines that are adjacent to only a single other tuning fork tine on the tuning fork base.

29. (New) The resonator according to claim 28, wherein:

a.) the electrical polarity of the at least one first electrode inside each of the at least one groove on of any given tuning fork tine is the same as the electrical polarity of each of the at least one second electrode on each side surface of each tuning fork tine adjacent to the given tuning fork tine;

b.) the electrical polarity of each of the at least one second electrode on each side of the given tuning fork tine is the same as the electrical polarity of the at least one first electrode inside each of the at least one groove on each tuning fork tine adjacent to the given tuning fork tine; and

c.) the electrical polarity in (a) and the electrical polarity in (b) are opposite.

30. (New) The resonator according to claim 28, wherein the height of each of the at least one groove in at least one of the central upper and central lower surfaces of each of the tuning fork tines extends to the base end of the tuning fork tine.

31. (New) The resonator according to claim 28, wherein there are from 2 to about 12 tuning fork tines.

32. (New) The resonator according to claim 31, wherein there are from 2 to about 6 tuning fork tines.

33. (New) The resonator according to claim 32, wherein there are 2 tuning fork tines.

34. (New) The resonator according to claim 28, wherein the tuning fork tines are linearly spaced apart from one another

35. (New) The resonator according to claim 28, wherein the tuning fork tines are angularly spaced apart from one another.

36. (New) The resonator according to claim 35, wherein the tuning fork tines are spaced apart from one another at an angle of from 0° to about 10°.

37. (New) The resonator according to claim 28, wherein when a voltage is applied across the electrode terminals in (e), an electric field is created having an orientation perpendicular to the electrodes on the tuning fork tines, resulting in a quartz crystal tuning fork resonator operating in a flexural mode and having a low series resistance and a high quality factor.

38. (New) A quartz crystal tuning fork resonator capable of vibrating in a flexural mode, the resonator comprising:

a.) a quartz crystal tuning fork base;

b.) a plurality of quartz crystal tuning fork tines, each tuning fork tine being parallelipiped in shape and having:

a base end that is attached to the tuning fork base, and a free top end opposite to the base end, the base end and the top end having a width and a length;

a pair of central surfaces, including a central upper surface and a central lower surface, the central upper surface and the central lower surface being disposed opposite to one another, and both of the central upper and lower surfaces being perpendicular to the base and top ends, with the central upper and lower surfaces having a width and a height; and

a pair of opposite first and second side surfaces, both of which are perpendicular to the base and top ends and perpendicular to the central upper and lower central surfaces, with each of the first and second side surfaces having a length and a height;

with each of the plurality of tuning fork tines being adjacent to at least one other tuning fork tine, and spaced apart therefrom on the tuning fork base by a predetermined distance, such that at least one of the first and second side surfaces of each tuning fork tine is adjacent to a side surface of at least one other adjacent tuning fork tine and is spaced apart therefrom by the predetermined distance between adjacent tuning fork tines;

c.) a plurality of grooves on the tuning fork base at a juncture of the tuning fork tines and the tuning fork base; and

d.) a plurality of electrodes in the grooves, such that there is at least one electrode in each groove.

REMARKS

Claims 1 – 17 were all of the claims in the applications as translated from the original Japanese priority application. Those claims contained several multiple dependent claims. Because applicant did not want to pay the higher fee for multiple dependent claims, those claims were amended to remove the multiple dependencies.

Several additional claims have been added to claim, in separate dependent claims, that subject matter which was originally claimed in the multiple dependent claims. Other amendments to the original set of claims have been made to more particularly set forth and distinctly claims the subject matter which applicant regards as the invention.

Several new claims have been added to claim subject matter and aspects of the invention that are disclosed in the application but were not specifically claimed in the original set of claims.

Still other new claims have been added to claim the subject matter of the original claims with greater particularity and in greater detail to afford a range of scope of the claims.

No new matter is added in any of the new claims. Support for all amendments to the original claims and newly added claims is found in the original specification and drawings.

A certified copy of the priority document, Japanese Patent Application No. 2000-332160, filed October 31, 2000, is also being filed herewith.

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Respectfully submitted

Howard R. Jaeger

Howard R.Jaeger
Reg. No. 31,376
Attorney for Applicant

ABELMAN, FRAYNE & SCHWAB
150 East 42 Street
New York, New York 10017
Tel.: (212) 949-9022
Fax.: (212) 949-9190

VERSION OF AMENDED CLAIMS SHOWING CHANGES MADE

Amend original claims 1 – 17, as follows:

1 (Amended). A ~~tuning fork,~~ quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, the resonator comprising~~;~~ :

a plurality of quartz crystal tuning fork tines, ~~and~~ each tuning fork tine having sides and a central linear portion;

a quartz crystal tuning fork base, to which the plurality of quartz crystal tuning fork tines are attached;

at least one groove provided in the central ~~line~~ linear portion of each of ~~said~~ the plurality of tuning fork tines~~,~~ :

at least one first electrode provided inside each groove~~,~~ ; and

at least one second electrode provided on the sides of ~~said~~ the tuning fork tines ~~, and~~ ;

such that for each tuning fork tine ~~said~~ each one of the at least one second electrode ~~having~~ has an opposite electrical polarity to ~~said~~ the electrical polarity of each one of the at least one first electrode.

2. (Amended) ~~A~~ The resonator ~~as defined in~~ according to claim 1, wherein:

the at least one first electrode inside the at least one groove of ~~the~~ a first tuning fork tine and the at least one second electrode disposed on the sides of ~~the~~ a second tuning fork tine ~~are~~ have the same first electrical polarity, and

the at least one second electrode disposed on the sides of the first tuning fork tine and the at least one first electrode inside the at least one groove of the second tuning fork tine ~~are the~~ have a second, opposite electrical polarity to the ~~said~~ first electrical polarity.

3. (Amended) ~~A~~ The resonator ~~as defined in~~ according to claim 2, wherein ~~said resonator comprises~~ the second electrode on outer facing sides of each of the first and second tuning fork tines that are each adjacent to only one other side of the same or another tuning fork tine on the tuning fork base, constitute two electrode terminals.

4. (Amended) ~~A~~ The resonator ~~as defined in~~ according to claim 1 ~~or claim 2~~, wherein the ~~grooves constructed~~ at least one groove provided on the central linear portion ~~including the central line~~ of each of the first and second tuning fork tines ~~extend~~ extends to the tuning fork base ~~coupled~~ to which each tuning fork tine is attached.

5. (Amended) ~~A~~ The resonator ~~as defined in~~ according to claim 1 ~~or claim 2~~, wherein ~~groove~~ a width W_2 ~~constructed~~ of each groove on the first and second tuning fork tines ~~are~~ is greater ~~to~~ than or equal to ~~the~~ a width W_1, W_3, measured from ~~the~~ an outer edge of the groove to ~~the~~ an outer edge of the tuning fork tine ~~W_1, W_3~~.

6. (Amended) A quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, the resonator comprising~~;~~ :

a plurality of quartz crystal tuning fork tines~~;~~ ;

a quartz crystal tuning fork base, having an obverse face and a reverse face, and to which the plurality of quartz crystal tuning fork tines are attached;

a plurality of grooves provided on the quartz crystal tuning fork base where ~~said base is coupled to~~ the plurality of quartz crystal tuning fork tines are attached to the quartz crystal tuning fork base;~~,~~ and

a plurality of electrodes provided in ~~said~~ the grooves, such that there is at least one electrode in each groove.

7. (Amended) ~~A~~ The resonator ~~as defined in~~ according to claim 6, wherein:

a first set of grooves ~~are constructed~~ is provided on the obverse and the reverse faces of the tuning fork base, where ~~said base connects to~~ each tuning fork tine is attached to the base~~,~~ ; and

a second set of grooves ~~are constructed~~ is provided on the obverse and the reverse faces ~~between said first set of grooves~~ of the tuning fork base, such that there is a second groove between each adjacent pair of first grooves.

8. (Amended) ~~A~~ The resonator ~~as defined in~~ according to claim 6 ~~or claim 7~~ , wherein:

the electrodes disposed opposite each other in the thickness direction of the grooves have the same polarity, and

the electrodes disposed opposite the sides of adjoining grooves have opposite polarities.

9. (Amended) ~~A~~ The quartz crystal tuning fork resonator ~~as defined in any proceeding claim~~ according to claim 6, wherein the tuning fork base has a plurality of grooves, and ~~said grooves containing the electrodes~~ each groove contains an electrode.

10. (Amended) A ~~tuning fork,~~ quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising;

a plurality of quartz crystal tuning fork tines~~,~~ ;

a quartz crystal tuning fork base, to which the plurality of quartz crystal tuning fork tines are attached;

~~said~~ each of the quartz crystal tuning fork tines having step difference portions~~,~~ ;

with there being at least one first electrode on each of the ~~said~~ step difference portions~~,~~ ;

with there being at least one second electrode disposed on ~~the side~~ sides of ~~said~~ the quartz crystal tuning fork tines, and;

~~said~~ such that the at least one first electrode and the at least one second ~~electrodes being~~ electrode are of opposite electrical polarity.

11. (Amended) ~~A~~ An integrated quartz crystal tuning fork resonator, capable of vibrating in a flexural mode, comprising a plurality of individual resonators ~~as claimed in any preceding~~ according to claim 1.

12. (Amended) ~~A~~ The integrated quartz crystal tuning fork resonator ~~comprising as defined in~~ according to claim 11, wherein ~~said~~ each of the plurality of ~~flexural mode, tuning fork, quartz crystal~~ individual resonators ~~are~~ is connected to at least one other individual resonator of the plurality of resonators at ~~each~~ their corresponding respective quartz crystal tuning fork ~~base~~ bases.

13. (Amended) ~~A~~ The integrated quartz crystal tuning fork resonator ~~comprising~~ according to claim 11, wherein~~;~~

~~a plurality of flexural mode, tuning fork, quartz crystal resonators being connected and formed integrally at each tuning fork base wherein said quartz crystal resonators are coupled~~ the corresponding respective tuning fork bases of individual resonators that are connected to ~~each other at the respective tuning fork bases and having~~ one another form an angle of ~~separation of~~ from 0° to about 30°.

14. (Amended) ~~A~~ The integrated quartz crystal tuning fork resonator ~~as defined in claims~~ according to claim11~~-13~~, wherein each of the plurality of individual quartz crystal tuning fork resonators ~~have~~ has at least one of a different ~~resonator~~ shape and~~/or~~ a different electrode ~~deposition~~ configuration.

15. (Amended) ~~A~~ The resonator ~~as defined in any of the claims~~ according to claim11, ~~12 or 13~~ wherein ~~said~~ the individual resonators are ~~arranged side by side~~ electrically connected in series.

16. (Amended) ~~A~~ The resonator ~~as defined in any of the claims~~ according to claim 11~~-15~~, wherein ~~said~~ the individual resonators are electrically connected in parallel.

17. (Amended) ~~A~~ The resonator ~~as defined in any of the claims~~ according to claim 1~~-7~~, wherein the grooves ~~constructed~~ formed on the tuning fork tines ~~and/or the tuning fork~~

~~base~~ are holes or a combination of ~~the~~ grooves and ~~the~~ holes, and ~~said~~ the holes or ~~said~~ grooves and holes ~~containing~~ contain the at least one first electrodes.